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(54) **Electrode system**

Elektrodensystem

Système d'électrodes

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Description

[0001] The present invention relates to an electrode system, intended to be implanted in a heart and connectable with a proximal end to a medical apparatus for monitoring, diagnosing and/or treating a heart, comprising an electrode lead, an atrial electrode, arranged on the electrode lead, for electrical connection to tissue in an atrium of the heart, and a first electrode conductor, arranged in the electrode lead, for connecting the atrial electrode to a first contact at the proximal end.

[0002] The present invention also relates to an electrode system, which further comprises a ventricular electrode, arranged on the electrode lead, for electrical connection to tissue in a ventricle of the heart and a second electrode conductor, arranged in the electrode lead, for connecting the ventricular electrode to a second contact at the proximal end.

[0003] The implantation of electrode systems in children is a problem encountered with electrode systems of today. The electrode lead between the medical apparatus and heart stretches as the child grows and damages tissue in the patient's body. To prevent this development, surplus electrode lead is sometimes implanted in a loop around the medical apparatus to serve as spare lead during the child's growth. However, utilizing this spare lead effectively requires surgery to introduce the necessary additional length of electrode lead into the bloodstream towards the heart.

[0004] Another problem with electrode systems is the need for a plurality of electrode leads for different uses, e.g. when both the ventricle and the atrium are to be stimulated or sensed (as in DDD-systems), when the atrium is to be stimulated and a physiological parameter is to be sensed.

[0005] A large number of physiological parameters related to the heart's function is known. In addition to the electrical signals from the heart, blood pressure, blood flow, oxygen saturation, pH, blood temperature etc. are parameters of interest. A plurality of these parameters can advantageously be measured in the ventricle, so two electrode leads are required when the atrium is to be stimulated and a physiological parameter is to be sensed in the ventricle.

[0006] Yet another problem occurs with electrode systems utilizing defibrillation electrodes to be placed in the heart for defibrillating the atrium, the ventricle or both. In particular the atrial defibrillation electrode is difficult to arrange in a steady position within the atrium.

[0007] For heart stimulators in which both the atrium and ventricle are to be stimulated and/or electrically sensed, a plurality of electrode systems has been devised to facilitate implantation and, primarily, to reduce the number of electrode leads which have to be implanted in the heart.

[0008] One such electrode system is described in US-A-4,567,901. The electrode system comprises a common electrode lead which divides up inside the heart into an atrial electrode lead and a ventricular electrode lead. Even if this electrode system can be manipulated into the heart during implantation, the atrial electrode and the ventricular electrode must still be positioned and affixed as if they were arranged on separate electrode leads.

[0009] Another prior art electrode system is described in US-A-4,444,195. This electrode system comprises a single electrode lead with one or a plurality of ventricular electrodes at the distal end of the electrode lead and one or a plurality of atrial electrodes arranged at an appropriate distance from the distal end. The electrode lead has a weak curvature between the ventricular electrodes and the atrial electrodes causing the latter to contact atrial tissue. One problem with this type of electrode system is that the electrical contact between the atrial electrodes and atrial tissue cannot be assured. It can, therefore, only be employed in VDD-systems and not in DDD-systems. This US-document discloses the features of the preamble of claim 1.

[0010] A similar electrode system is described in US-A-4,154,247. However, the electrode lead in this electrode system is devised with more geometric variations at the atrial electrode. For example, the electrode lead in one embodiment is laid in a circle to enable the atrial electrode to establish continuous electrical contact with atrial tissue. In another embodiment, the electrode lead is S-shaped at the atrial electrode. Essentially the same problems occur with this electrode system. It cannot, therefore, be employed in a full range DDD-system.

[0011] One object of the invention is to achieve an electrode system which can easily be implanted in a heart and which solves the above-described problems.

[0012] Another object of the invention is to achieve an electrode system which can easily be implanted in a heart and which simply and effectively ensures electrical contact between both atrial tissue and ventricular tissue.

[0013] A further object of the invention is to achieve an electrode system with a minimum number of electrode leads and which can be used in a plurality of different versions for both normal atrial pacing and defibrillation.

[0014] An electrode system in which electrical stimulation and/or sensing is assured in both the atrium and the ventricle is achieved in accordance with the invention in that the electrode system, as described above, is devised so the atrial electrode is arranged at the distal end of the electrode lead and the ventricular electrode is arranged at a distance of 1 to 15 cm, preferably from 8 to 15 cm, from the distal end. The ventricular electrode is a ring electrode having an area of 4-10 mm^2.

[0015] Placement of the atrial electrode at the distal end conveys the special advantage that the atrial electrode can be introduced into and affixed to tissue in the atrium before the ventricular electrode is advanced down into the ventricle and affixed to the ventricular trabeculae. The portion of the electrode lead between the atrial electrode and the ventricular electrode is pref-

erably made extremely flexible, so that it may be introduced into the ventricle to form a loop between the atrial electrode and the ventricular electrode. Thus implantation is simplified at the same time as good electrical contact with tissue in both the atrium and in the ventricle is assured.

[0016] The distance between the tip electrode (atrial electrode) and the ring electrode (ventricular electrode) is greater than in prior art electrode systems due to the extra curvature (and possible loop) of the electrode lead in the ventricle.

[0017] The orientation of the first contact and the second contact at the proximal end remains the same as in the prior art in order to fit for prior art apparatus. This means that the connection between electrode and contact is only reversed at the end of the electrode lead, compared with prior art electrode systems.

[0018] Further, the area of the ring electrode surface differs essentially between prior art electrode systems and the new electrode system. For example, a ring electrode (atrial electrode) in a prior art electrode system can have an area of 20-35 mm^2 whereas the ring electrode (ventricular electrode) of the new inventive electrode system has an area of 4-10 mm^2.

[0019] As both the atrial electrode and the ventricular electrode are in secure electrical contact with tissue in both the atrium and the ventricle, the present electrode system can be used for all functions in a DDD-system with only one electrode lead.

[0020] A refinement of the electrode system is achieved in accordance with the invention in that the electrode lead is devised with an essentially semicircular curvature near the ventricular electrode, said curvature corresponding to the geometry of the heart in the implantation area.

[0021] The preshaped curved part of the electrode lead will be in the ventricle, where the electrode lead is laid in a loop. The curvature facilitates implantation of the electrode system and minimizes mechanical loads imposed on the heart by the electrode system after implantation.

[0022] It is an advantage here if the electrode lead is devised with a second curvature at the distal end. The second curvature should preferably have an angle of curvature of 60° to 120° and curve in the opposite direction to the curvature near the ventricular electrode.

[0023] The atrial electrode is normally affixed to the upper part of the septum between the atria. At the distal end, a second preshaped curvature, which curves in the opposite direction to the curvature near the ventricular electrode, gives the electrode system a shape making it more suitable to its location in the heart. The second curvature also conveys the additional advantage that it is easier for the physician implanting the electrode system to orient her-/himself in the atrium, since the curved end of the distal part of the electrode lead makes it easier for the physician to find the coronary sinus, an orientation point during implantation. It may also be advantageous in some patients to place the atrial electrode in or near the coronary sinus.

[0024] The atrial electrode is appropriately devised with an active or passive first fixation device. To facilitate fixation of the ventricular electrode in the ventricle, it is an advantage if it is devised with an active or a passive second fixation device. An active fixation device could consist of a screw or a hook, manipulated by a physician with a stylet and affixed to heart tissue during implantation of the electrode system. A passive fixation device could consist of fixed projection from the electrode lead at the electrodes, e.g. tines or fins. A passive fixation device ultimately becomes embedded in heart tissue. Such active or passive fixation devices have hitherto not been used for electrodes arranged at a distance from the end of the electrode lead. It should here be noted that a ring electrode utilized as a ventricular electrode located in the ventricle will display other properties than a prior art ring electrode. Also, the conditions for tissue growth are somewhat different for ring electrodes located in the atrium and ring electrodes located in the ventricle, in particular when the ventricular ring electrode is located at the apex.

[0025] One refinement of the electrode system is achieved in accordance with the invention in that at least one additional atrial electrode is arranged on the electrode lead near the atrial electrode and at least one additional first electrode conductor is arranged in the electrode lead in order to connect the additional atrial electrode to an additional first contact at the proximal end.

[0026] Alternately, or as an additional complement, at least one additional ventricular electrode can be arranged on the electrode lead by the ventricular electrode and at least one additional second electrode conductor is arranged in the electrode lead in order to connect the additional ventricular electrode to an additional second contact at the proximal end.

[0027] This would yield a bipolar or multipolar system for both the atrium and the ventricle.

[0028] The range of uses for the electrode system would be further extended if the electrode system were further devised according to the invention so at least one defibrillation electrode is arranged on the electrode lead between the atrial electrode and the ventricular electrode and/or between the ventricular electrode and the proximal end and if at least one defibrillation electrode conductor is arranged in the electrode lead in order to connect the defibrillation electrode to a defibrillation contact at the proximal end.

[0029] An electrode system for stimulating and sensing the heart, as well as defibrillating the heart, is hereby achieved on a single electrode lead, thereby greatly facilitating implantation and shortening implantation time. Furthermore, the electrode lead can be fixed within the heart in a manner previously not known, and the defibrillation electrodes will be held steady within the heart, thereby overcoming the problem described above.

[0030] Problems in the implantation of children are

solved in accordance with the invention in that the electrode system, as described above, is devised so the electrode lead can be laid in a loop in a ventricle of the heart during implantation of the electrode system.

[0031] This would thereby provide spare electrode lead inside the heart. As the child grows, a sufficient amount of lead is automatically withdrawn from the ventricle. No surgery is needed. It would hereby be an advantage if the electrode lead were devised with an essentially semicircular curvature at a distance of 1 to 15 cm, preferably 5 to 10 cm, from the distal end.

[0032] In conjunction with simultaneous measurement of a physiological variable and electrical stimulation/sensing in the atrium, it is advantageous if a physiological sensor is arranged on the electrode lead in order to sense the physiological parameter.

[0033] It is especially advantageous if the physiological sensor is arranged near the curvature in order to sense the physiological parameter in the ventricle.

[0034] A complete, multifunctional electrode system is achieved in accordance with an embodiment of the invention in that the electrode system further comprises at least one additional atrial electrode connected to at least one corresponding contact at the proximal end of the electrode lead and/or at least one ventricular electrode arranged near a curvature and connected to at least one corresponding contact at the proximal end of the electrode lead, and/or at least one defibrillation electrode arranged between the atrial electrode and the curvature and/or between the curvature and the proximal end and connected to at least one corresponding contact at the proximal end.

[0035] Five embodiments of the electrode system according to the invention will now be described in greater detail, referring to the figures in which

FIG. 1 shows a first embodiment of the electrode system implanted in a heart;

FIG. 2 shows a second embodiment of the electrode system;

FIG. 3 shows a third embodiment of the electrode system;

[0036] In FIG. 1 is shown a pacemaker 2 which has been connected to a heart 4 with an electrode system 6. The electrode system 6 comprises an electrode lead 8 introduced into the heart 4 via the blood circulation. An atrial electrode 10 is connected to tissue in the atrium of the heart 4 and, via an electrode conductor (not shown), to a first contact 12 at the proximal end of the electrode lead 8 for electrical connection to the pacemaker 2. A ventricular electrode 14 is connected to tissue in a ventricle of the heart 4 and, via an electrode conductor (not shown), to a second contact 16 for electrical connection to the pacemaker 2. The distance between the atrial electrode 10 and the ventricular electrode 14 can e.g. be 12 cm. The portion of the electrode lead 8 between the atrial electrode 10 and the ventricular electrode 14 can also display a complete loop inside the ventricle. The special new design of the electrode lead 8, with a reversed order of the atrial electrode 10 and the ventricular electrode 14 greatly facilitates implantation of the electrode system 6 and increases its functionality.

[0037] One or a plurality of stylet(s) can be used during the implantation. In principle, implantation is performed by advancing the electrode lead 8 into the heart 4 and affixing the atrial electrode 10 to tissue in the atrium, e.g. in the trabecular network. The part of the stylet between the atrial electrode 10 and the ventricular electrode 14 is then retracted into the electrode lead 8, and the electrode lead 8 is advanced into the heart 4 so the ventricular electrode 14 passes down into the ventricle where it is subsequently affixed to ventricular tissue, preferably near the apex. During this operation, the electrode lead 8 can be allowed or forced to form a loop (not shown in this embodiment) within the ventricle.

[0038] The electrode lead 8 is specifically designed to be able to pass the tricuspid valve twice without causing any stress or irritation on heart tissue. Preferably, the end portion of the electrode lead 8, i.e. the portion between the ventricular electrode 14 and the atrial electrode 10 is made significantly thinner than the rest of the electrode lead 8. The thinner portion will only cause little interference with the tricuspid valve leaflets. This can be made without any difficulty since there will be fewer conductors in the thinner portion (in the embodiment of FIG. 1, only one conductor).

[0039] The electrode system 6 can be used in a unipolar DDD-system, utilizing all DDD-functions in stimulating and sensing both the atrium and the ventricle in the heart 4. No reliable single lead DDD electrode system has hitherto been developed. The unipolar feature means that all pacing and sensing in the atrium and ventricle are made over the atrial electrode 10 and an indifferent electrode (not shown) on the pacemaker and over the ventricular electrode 14 and the indifferent electrode. However, sensing can also be: made atrioventricularly, i.e. over the atrial electrode 10 and the ventricular electrode 14. An electrode system utilizing bipolar possibilities is shown below. The electrode system 6 can, naturally, be utilized in other unipolar pacing systems as well, such as unipolar VDD-systems, etc.

[0040] A second embodiment is shown in FIG. 2, in which the electrode system 18 is devised with a first atrial electrode 20, electrically connected to a first contact 22, and a second atrial electrode 24, electrically connected to a second contact 26 at the proximal end of an electrode lead 19. The electrode system 18 further has a first ventricular electrode 28, electrically connected to a third contact 30, and a second ventricular electrode 32, electrically connected to a fourth contact 34. Near the atrial electrodes 20, 24, the electrode system 18 is devised with a passive fixation device 36 intended for attachment to the atrial trabecular network. Near the first ventricular electrode 28, the electrode system 18 is de-

vised with an active fixation device 38. The active fixation device 38 could e.g. be devised as an eccentric hook. One such active fixation device is described in EP-A-0 570 712. Other known active fixation means can also be utilized with the electrode system 18.

[0041] The electrode system 18 is devised with a first, semicircular curvature 37 near the ventricular electrodes 28, 32 and a second curvature 39 near the atrial electrodes 20, 24. The design with the curvatures 37, 39 facilitates implantation of the electrode system 18 and reduces mechanical loads on the heart after implantation. Although the curvatures 37, 39 are preshaped curves, the electrode lead 19 is in itself very flexible and adapts smoothly to the shape of the interior of the heart.

[0042] The electrode system 18 can replace all bipolar electrode systems using two leads (one for the atrium and one for the ventricle). In particular, it can be utilized in bipolar DDD-systems, performing all DDD functions. If used with a pacemaker having an indifferent electrode on its housing, it can also utilize all unipolar functions described above in connection with FIG. 1.

[0043] A third embodiment of the invention is shown in FIG. 3. An electrode system 40 comprises an electrode lead 42 which at its distal end is equipped with a first atrial electrode 44, electrically connected to a first contact 46, and a second atrial electrode 48, electrically connected to a second contact 50. Like the electrode system 18 in FIG. 2, the electrode system 40 comprises a first ventricular electrode 52, electrically connected to a third contact 54, and a second ventricular electrode 56, electrically connected to a fourth contact 58. A first passive fixation device 68 is arranged near the atrial electrodes 44, 48, and a second passive fixation device 70 is arranged near the ventricular electrodes 52, 56.

[0044] The electrode system 40 is intended for use with a defibrillator with pacing functions. So the electrode system 40 also comprises a first defibrillation electrode 60, electrically connected to a fifth contact 62, and a second defibrillation electrode 64, electrically connected to a sixth contact 66. The first defibrillation electrode 60 has been placed at a distance from the distal end of the electrode lead 42, thereby positioning the first defibrillation electrode 60 in the ventricle after implantation, and the second defibrillation electrode 64 is arranged on the electrode lead 42 so it is positioned in the vena cava after implantation.

[0045] Regarding the pacing and sensing abilities, the electrode system can utilize all combinations described with the embodiments of FIGS. 1 and 2. The first defibrillation electrode 60 can replace the second ventricular electrode 56 for all its sensing and pacing functions and the second defibrillation electrode 64 can replace the second atrial electrode 48. The number of electrodes in the electrode system 40 can thus be reduced further, without loosing any of its functional possibilities.

[0046] All known defibrillation activities for this kind of defibrillation system can be utilized. E.g. atrial defibrillation over the first defibrillation electrode 60 and an indifferent electrode (not shown, but can be any of the well known indifferent electrodes for defibrillation systems) and ventricular defibrillation over the second defibrillation electrode 64 and the indifferent electrode. Ventricular defibrillation can also be made over the second defibrillation electrode 64 and the first defibrillation electrode 60, over the second defibrillation electrode 64 and the indifferent electrode interconnected with the first defibrillation electrode 60 and multipotentially over the second defibrillation electrode 64 and both the indifferent electrode and the first defibrillation electrode 60 (whereby different voltages are utilized at the different points; the multipotential defibrillation pulse can be biphasic, mulitiphasic, sequential, etc.). It should be noted that for some of the defibrillation configurations, the indifferent electrode will act more as an active defibrillation electrode, in particular when multipotential defibrillation pulses are used.

[0047] The first defibrillation electrode 60 and the second defibrillation electrode 64 can also be used for sensing functions. So called "vectoral sensing" can be made over each of the defibrillation electrodes 60, 64 and the indifferent electrode. The sensing properties are enhanced due to the new arrangement of the electrode system. The first defibrillation electrode 60 will have a stable position since the portion of the electrode lead 42 displaying the first defibrillation electrode is anchored in both the atrium and the ventricle. (This also enhances the defibrillation function.) Not only sensing of the electrical activity, but also impedance measurements can be utilized in any combination of electrodes.

[0048] Thus, all pacing, sensing and defibrillation functions can be utilized with the electrode system 40, which comprises only one lead.

[0049] The electrode conductors (not shown) in the respective embodiments could be arranged in the electrode lead in some known manner, e.g. as parallel, helically coiled wires, electrically insulated from each other. Alternately, the electrode conductors could run helically and concentricity (coaxially) in relation to one another in the electrode lead or as some combination thereof, i. e. both parallel and concentric, depending on the number of electrode conductors required.

[0050] The construction of electrode system is not limited to the above embodiments. The different features of the described embodiments can be combined in several ways, e.g. by having only a physiological sensor and defibrillation electrodes on the same electrode lead with fixation devices for attaching it in the atrium and ventricle, active and passive fixation devices can be combined in several different arrangements for fixing the different portions of the electrode lead to the heart tissue. The electrode system can also be equipped with more atrial and/or ventricular electrodes, thereby becoming multipolar in both the atrium and the ventricle. The number and location of defibrillation electrodes and the physiological sensor on the electrode lead can also be varied.

Claims

1. Electrode system (6; 18; 40) intended to be implanted in a heart (4) and connectable with a proximal end to a medical apparatus (2) for monitoring, diagnosing and/or treating a heart (4), comprising an electrode lead (8; 19; 42), an atrial electrode (10; 20; 44), arranged on the electrode lead (8; 19; 42) for electrical connection to tissue in an atrium of the heart (4), a first electrode conductor, arranged in the electrode lead (8; 19; 42) for connecting the atrial electrode (10; 20; 44) to a first contact (12; 22; 46) at the proximal end, a ventricular electrode (14; 28; 52), arranged on the electrode lead (8; 19; 42) for electrical connection to tissue in a ventricle of the heart (4) and a second electrode conductor, arranged in the electrode lead (8; 19; 42) for connecting the ventricular electrode (14; 28; 52) to a second contact (16; 30; 54) at the proximal end, **characterized in that** said atrial electrode (10; 20; 44) is arranged at the distal end of the electrode lead (8; 19; 42), and **in that** the ventricular electrode (14; 28; 52) is arranged at a distance of 1 to 15 cm, preferably from 8 to 15 cm, from the distal end, said ventricular electrode being a ring electrode and having an area of 4 - 10 mm^2.

2. Electrode system according to claim 1, **characterized in that** the electrode lead (19; 42) is devised with an essentially semicircular curvature (37; 69) near the ventricular electrode (28; 52), said curvature (37; 69) corresponding to the geometry of the heart in the implantation area.

3. Electrode system according to claim 2, **characterized in that** the electrode lead (19; 42) is devised with a second curvature (39; 71) near the distal end.

4. Electrode system according to claim 3, **characterized in that** the second curvature (39; 71) has an angle of curvature from 60° to 120° and is curved in the opposite direction in relation to the curvature (37; 69) near the ventricular electrode (28; 52).

5. Electrode system according to any of the above claims, **characterized in that** the atrial electrode (20; 44) is devised with an active or a passive first fixation device (36; 68).

6. Electrode system according to any of the above claims, **characterized in that** the ventricular electrode (28; 52, 56) is devised with an active or a passive second fixation device (38; 70).

7. Electrode system according to any of the above claims, **characterized in that** at least one additional atrial electrode (24; 48) is arranged on the electrode lead (19; 42) near the atrial electrode (20; 44) and at least one additional first electrode conductor is arranged in the electrode lead (19; 42) in order to connect the additional atrial electrode (24; 48) to an additional first contact (26; 50) at the proximal end.

8. Electrode system according to any of the above claims, **characterized in that** at least one additional ventricular electrode (32; 56) is arranged on the electrode lead (19; 42) near the ventricular electrode (28; 52), and at least one additional second electrode conductor is arranged in the electrode lead (19; 42) in order to connect the additional ventricular electrode (32; 56) to an additional second contact (34; 58) at the proximal end.

9. Electrode system according to any of the above claims, **characterized in that** at least one defibrillation electrode (60; 64) is arranged on the electrode lead (42) between the atrial electrode (44) and the ventricular electrode (52) and/or between the ventricular electrode (52) and the proximal end, and at least one defibrillation electrode conductor is arranged in the electrode lead (42) in order to connect the defibrillation electrode (60, 64) to a defibrillation contact (62, 66) at the proximal end.

Patentansprüche

1. Elektrodensystem (6; 18; 40) zum Implantieren in ein Herz (4) und mit einem proximalen Ende anschließbar an ein medizinisches Gerät (2) zum Überwachen, Diagnostizieren und/oder Behandeln eines Herzens (4), enthaltend

   eine Elektrodenleitung (8; 19; 42),
   eine atrielle Elektrode (10; 20; 44), die an der Elektrodenleitung (8; 19; 42) angeordnet ist, für eine elektrische Verbindung mit einem Gewebe in einem Atrium des Herzens (4),
   einen in der Elektrodenleitung (8; 19; 42) angeordneten ersten Elektrodenleiter zum Verbinden der atriellen Elektrode (10; 20; 44) mit einem ersten Kontakt (12; 22; 46) am proximalen Ende, eine an der Elektrodenleitung (8; 19; 42) angeordnete ventrikuläre Elektrode (14; 28; 52) für eine elektrische Verbindung mit einem Gewebe in einem Ventrikel des Herzens (4)
   und einen in der Elektrodenleitung (8; 19; 42) angeordneten zweiten Elektrodenleiter zum Verbinden der ventrikulären Elektrode (14; 28; 52) mit einem zweiten Kontakt (16; 30; 54) am proximalen Ende, **dadurch gekennzeichnet, daß** die genannte atrielle Elektrode (10; 20; 44) am distalen Ende der Elektrodenleitung (8; 19; 42) angeordnet ist, und daß die ventrikuläre Elektrode (14; 28; 52) in einem Abstand von 1 bis 15 cm, vorzugsweise von 8 bis 15 cm, vom

distalen Ende entfernt angeordnet ist, wobei die genannte ventrikuläre Elektrode eine Ringelektrode mit einem Bereich von 4 bis 10 mm^2 ist.

2. Elektrodensystem nach Anspruch 1, **dadurch gekennzeichnet, daß** die Elektrodenleitung (19; 42) in der Nähe der ventrikulären Elektrode (28; 52) mit einer im wesentlichen halbkreisförmigen Krümmung (37; 69) ausgebildet ist, wobei die Krümmung (37; 69) der Geometrie des Herzens im Implantationsbereich entspricht.

3. Elektrodensystem nach Anspruch 2, **dadurch gekenn-zeichnet, daß** die Elektrodenleitung (19; 42) mit einer zweiten Krümmung (39; 71) in der Nähe des distalen Endes ausgebildet ist.

4. Elektrodensystem nach Anspruch 3, **dadurch gekenn-zeichnet, daß** die zweite Krümmung (39; 71) einen Krümmungswinkel von 60° bis 120° aufweist und die Krümmung in entgegengesetzter Richtung zur Krümmung (37; 69) in der Nähe der ventrikulären Elektrode (28; 52) verläuft.

5. Elektrodensystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die atrielle Elektrode (20; 44) ausgebildet ist mit einer aktiven oder einer passiven ersten Befestigungsvorrichtung (36; 68).

6. Elektrodensystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die ventrikuläre Elektrode (28; 52, 56) ausgebildet ist mit einer aktiven oder einer passiven zweiten Befestigungsvorrichtung (38; 70).

7. Elektrodensystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** wenigstens eine zusätzliche atrielle Elektrode (24; 48) an der Elektrodenleitung (19; 42) nahe der atriellen Elektrode (20; 44) angeordnet ist und wenigstens ein zusätzlicher erster Elektrodenleiter in der Elektrodenleitung (19; 42) angeordnet ist, um die zusätzliche atrielle Elektrode (24; 48) mit einem zusätzlichen ersten Kontakt (26; 50) am proximalen Ende zu verbinden.

8. Elektrodensystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** wenigstens eine zusätzliche ventrikuläre Elektrode (32; 56) an der Elektrodenleitung (19; 42) nahe der ventrikulären Elektrode (28; 52) angeordnet ist und wenigsten ein zusätzlicher zweiter Elektrodenleiter in der Elektrodenleitung (19; 42) angeordnet ist, um die zusätzliche ventrikuläre Elektrode (32; 56) mit einem zusätzlichen zweiten Kontakt (34; 58) am proximalen Ende zu verbinden.

9. Elektrodensystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** wenigstens eine Defibrillationselektrode (60; 64) an der Elektrodenleitung (42) zwischen der atriellen Elektrode (44) und der ventrikulären Elektrode (52) und/oder zwischen der ventrikulären Elektrode (52) und dem proximalen Ende angeordnet ist und wenigstens ein Defibrillationselektrodenleiter in der Elektrodenleitung (42) angeordnet ist, um die Defibrillationselektrode (60, 64) mit einem Defibrillationskontakt (62, 66) am proximalen Ende zu verbinden.

Revendications

1. Système (6 ; 18 ; 40) d'électrodes destiné à être implanté dans un coeur (4) et pouvant être connecté par une extrémité proximale à un appareil (2) médical pour surveiller, diagnostiquer et/ou traiter un coeur (4), comportant un câble (8 ; 19 ; 42) d'électrodes, une électrode (10; 20 ; 44) auriculaire, disposée sur le câble (8; 19 ; 42) d'électrodes pour une connexion électrique à des tissus dans une oreillette du coeur (4), un premier conducteur d'électrodes, disposé dans le câble (8 ; 19, 42) d'électrodes pour connecter l'électrode (10 ; 20 ; 44) auriculaire à un premier contact (12 ; 22 ; 46) à l'extrémité proximale, une électrode (14 ; 28 ; 52) ventriculaire disposée sur le câble (8 ; 19 ; 42) d'électrodes pour une connexion électrique à des tissus dans un ventricule du coeur (4) et un second conducteur d'électrodes, disposé dans le câble (8 ; 19 ; 42) d'électrodes pour connecter l'électrode (14, 28 ; 52) ventriculaire à un second contact (16; 30; 54) à l'extrémité proximale, **caractérisé en ce que** l'électrode (10 ; 20 ; 44) auriculaire est disposée à l'extrémité distale du câble (8 ; 19 ; 42) d'électrodes, et **en ce que** l'électrode (14 ; 28 ; 52) ventriculaire est disposée à une distance de 1 à 15 cm, de préférence 8 à 15 cm, de l'extrémité distale, l'électrode ventriculaire étant une électrode annulaire et ayant une aire de 4 à 10 mm^2.

2. Système d'électrodes suivant la revendication 1, **caractérisé en ce que** le câble (19 ; 42) d'électrodes est conçu en ayant une courbure (37 ; 69) sensiblement semi-circulaire à proximité de l'électrode (28 ; 52) ventriculaire, la courbure (37 ; 69) correspondant à la géométrie du coeur dans la zone d'implantation.

3. Système d'électrodes suivant la revendication 2, **caractérisé en ce que** le câble (19 ; 42) d'électrodes est conçu en ayant une seconde courbure (39 ; 71) à proximité de l'extrémité distale.

4. Système d'électrodes suivant la revendication 3, **caractérisé en ce que** la seconde courbure (39 ;

71) a un angle de courbure compris entre 60 et 120° et est incurvé dans la direction opposée par rapport à la courbure (37 ; 69) à proximité de l'électrode (28 : 52) ventriculaire.

5. Système d'électrodes suivant l'une quelconque des revendications précédentes, **caractérisé en ce que** l'électrode (20; 44) auriculaire est conçue en ayant un premier dispositif de fixation (36 ; 68) actif ou passif.

6. Système d'électrodes suivant l'une quelconque des revendications précédentes, **caractérisé en ce que** l'électrode (28 ; 52 ; 56) ventriculaire est conçue en ayant un second dispositif (38 ; 70) de fixation actif ou passif.

7. Système d'électrodes suivant l'une quelconque des revendications précédentes, **caractérisé en ce qu'**au moins une électrode (24 ; 48) auriculaire supplémentaire est disposée sur le câble (19 ; 42) d'électrodes à proximité de l'électrode (20 ; 44) auriculaire et au moins un premier conducteur d'électrodes supplémentaire est disposé dans le câble (19 ; 42) d'électrodes afin de relier l'électrode (24 ; 48) auriculaire supplémentaire à un premier contact (26 ; 50) supplémentaire à l'extrémité proximale.

8. Système d'électrodes suivant Tune quelconque des revendications précédentes, **caractérisé en ce qu'**au moins une électrode (32 ; 56) ventriculaire supplémentaire est disposée sur le câble (19 ; 42) d'électrodes à proximité de l'électrode (28 ; 52) ventriculaire, et au moins un second conducteur d'électrodes supplémentaire est disposé dans le câble (19 ; 42) d'électrodes afin de relier l'électrode (32 ; 56) veritriculaire supplémentaire à un second contact (34 ; 58) supplémentaire à l'extrémité proximale.

9. Système d'électrodes suivant l'une quelconque des revendications précédentes, **caractérisé en ce qu'**au moins une électrode (60 ; 64) de défibrillation est disposée sur le câble (42) d'électrodes entre l'électrode (44) auriculaire et l'électrode (52) ventriculaire et/ou entre l'électrode (52) ventriculaire et l'extrémité proximale, et au moins un conducteur d'électrodes de défibrillation est disposé dans le câble (42) d'électrodes afin de connecter l'électrode (60, 64) de défibrillation à un contact (66, 66) de défibrillation à l'extrémité proximale.

FIG 1

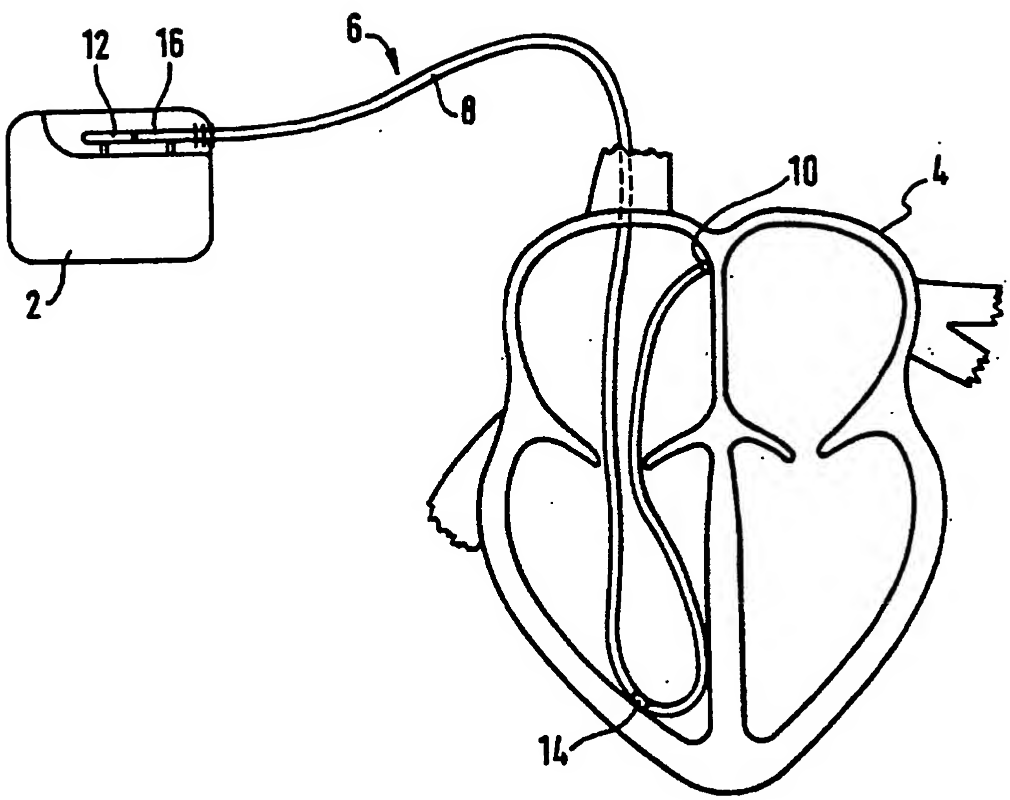

FIG 2

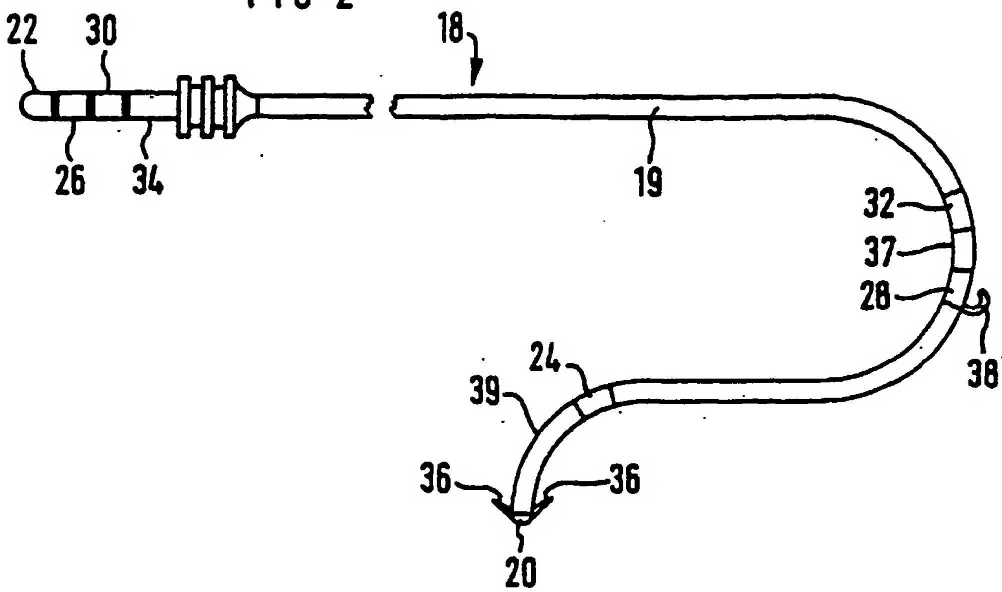
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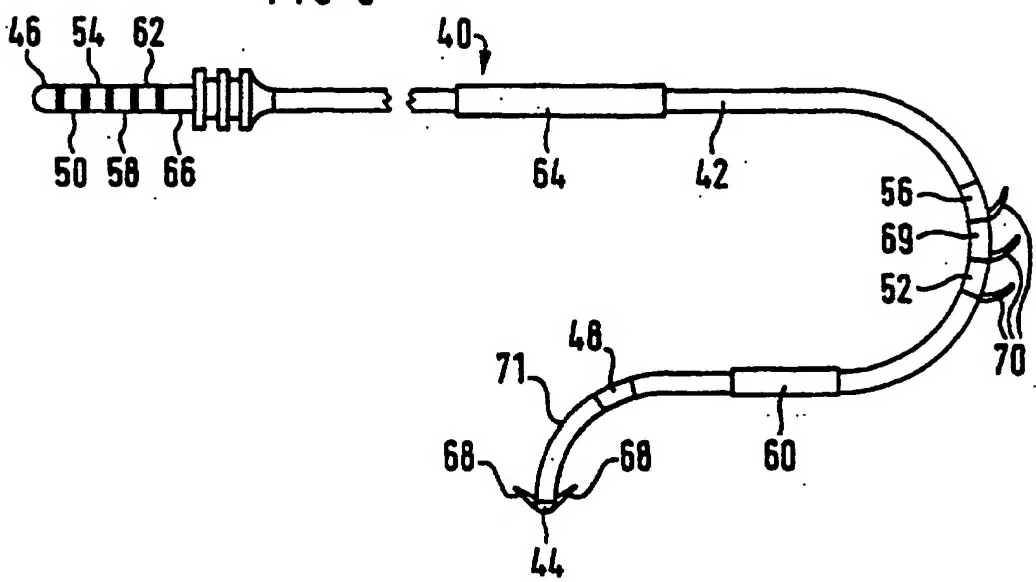
FIG 3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